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Forest Insect & Disease Management
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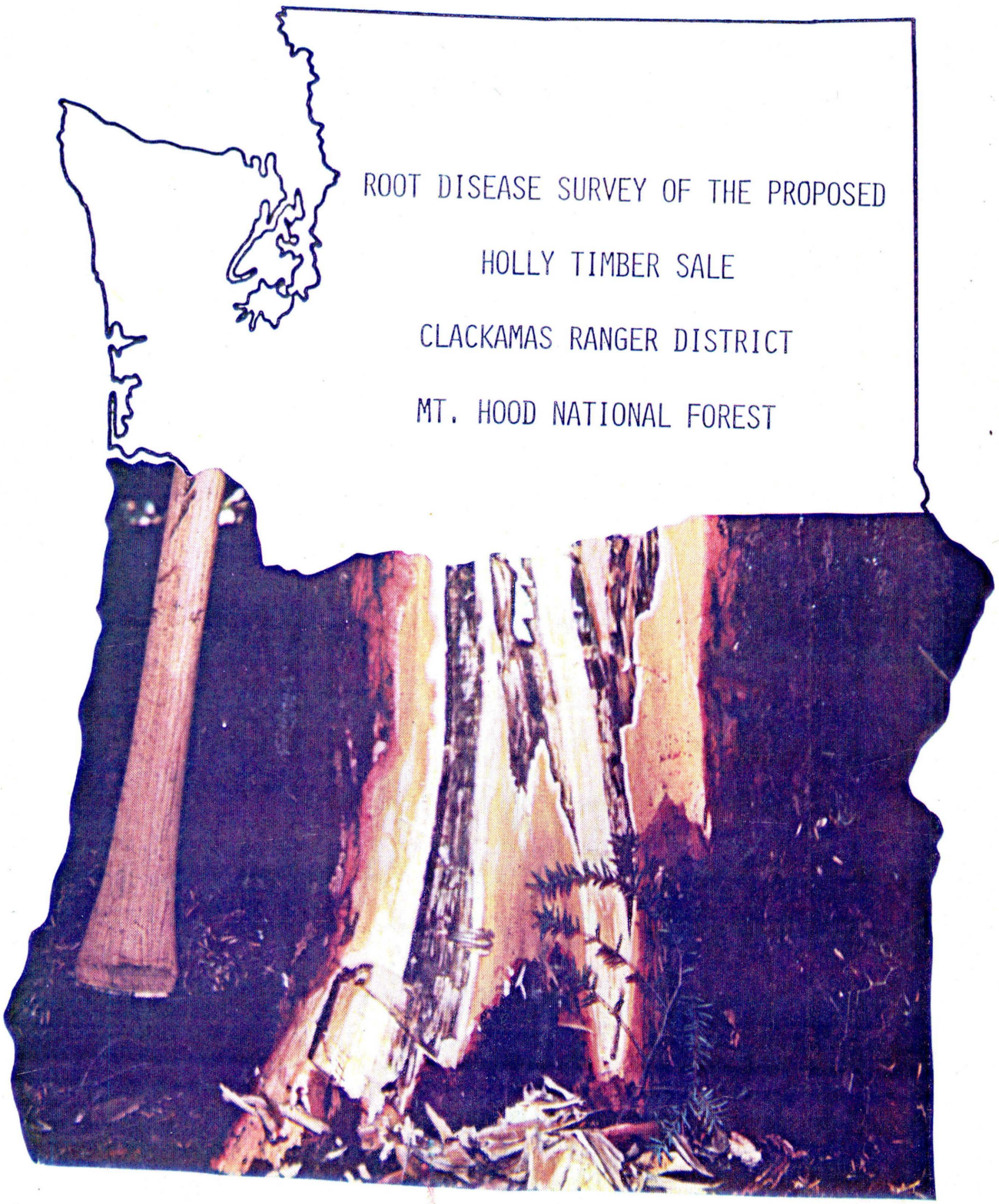

ROOT DISEASE SURVEY OF THE PROPOSED

HOLLY TIMBER SALE

CLACKAMAS RANGER DISTRICT

MT. HOOD NATIONAL FOREST

ROOT DISEASE SURVEY OF THE PROPOSED HOLLY TIMBER SALE, CLACKAMAS RANGER DISTRICT, MT. HOOD NATIONAL FOREST

by

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INTRODUCTION

During the week of August 19-22, 1980, a root disease evaluation was done on the proposed Holly Timber Sale (T. 6 S., R. 9 E., Sec. 23 along Road S-655, Figure 1), Clackamas Ranger District, Mt. Hood National Forest. Purposes of the evaluation were to determine identity and incidence of root diseases, quantify associated damage, and provide management recommendations to minimize present and future losses.

METHODS

A systematic sampling method was used to survey the stand. Variable plots (BAF 40) were located on a 2x2 chain grid across the unit. All trees in each prism plot were tallied, and the following information was recorded for each: tree species, dbh, and general condition (live, dead, standing, down). In addition, the root collar of each tree was exposed, and two roots on opposite sides of the stem were excavated to a distance of 3 feet and examined for evidence of root diseases. Presence of fungus sporophores on tree stems or dwarf mistletoe infections in crowns was also noted. A .01-acre fixed-area plot also was established at each plot center for the purpose of assessing disease severity in trees too small to be measured on the prism plot. All trees greater than 6 inches tall and less than 5 inches dbh in the fixed-area plots were tallied and examined for diseases. From the data collected in prism plots, mean basal area, number of trees, and volume per acre were calculated by tree species, dbh class, and disease condition.

RESULTS

The stand examined was composed predominantly of old-growth western hemlock (*Tsuga heterophylla*) and Douglas-fir (*Pseudotsuga menziesii*). Examination of stumps of salvaged Douglas-firs and hemlocks at the margin of the stand showed an average age of 196 years (range 175 to 282). Western white pine (*Pinus monticola*) also had occurred in the stand, but only dead trees of this species were encountered in the survey.

Mean basal areas, numbers of trees, and cubic foot volumes per acre for the survey unit are summarized in Tables 1, 2, and 3.

The root disease most commonly encountered in the survey area was black stain root disease caused by *Ceratocystis wageneri* (=*Verticicladiella wageneriі*). This disease was identified by the dark brown to black stain in the sapwood of roots and lower boles of infected trees. Identity was confirmed by culturing chips of stained wood on malt agar. The fungus produced characteristic conidiophores (asexual fruiting bodies) that were readily identified microscopically. *Ceratocystis wageneri* was infecting 32.2 percent of the western hemlocks (containing 30.4 percent of the hemlock volume) and had already killed 23.6 percent (containing 21.8 percent of the volume). It also was found infecting 3.7 percent of all small western hemlocks on fixed-area plots. Western hemlock was the only tree species infected by *C. wageneri*. The disease tended to occur in well-defined infection centers. Distribution is shown in Figure 2.

Shoestring root rot, caused by *Armillaria mellea*, also was common in the survey area. This disease was identified by the thick, white, mycelial fans formed under bark of roots and butts, shoestring-like infective structures called rhizomorphs, and a stringy, wet decay marked with numerous zone lines. In West Side stands, *Armillaria mellea* commonly invades trees weakened by some other cause, and in this survey, it always was found in association with *C. wageneri*. *Armillaria mellea* was found infecting 4.6 percent of the western hemlocks (containing 4.3 percent of the hemlock volume). Distribution of the pathogen is shown in Figure 3.

Annosus root rot, caused by *Fomes annosus*, was detected on some western hemlocks in the survey area. *Fomes annosus* causes a brownish stain in the wood and a white, stringy rot with black specks in decayed butts and roots. If infected wood is cultured on agar media, imperfect fruiting structures (*Oedocephalum*) are formed. This technique was used to confirm infection in two roots sampled in the survey area. *Fomes annosus* rarely causes death of western hemlocks. Rather, it causes a heart rot of the butts and sometimes the lower boles. In old-growth trees, wood volume lost to this pathogen can be quite significant. It normally causes little damage in trees under 125 years of age unless they have open wounds. No complete stand survey for *F. annosus* was attempted in this evaluation because such a survey requires destructive sampling of entire trees. Based on past studies, we would expect that at least 25 percent of the western hemlock trees in the stand are infected, but this does not necessarily mean that all have columns of advanced decay caused by this fungus.

Fifty-four percent of the Douglas-firs encountered in the survey area (containing 29.5 percent of the Douglas-fir volume) were dead. Examination of these dead trees showed that nearly all had red-brown root and butt rot caused by *Phaeolus (Polyporus) schweinitzii*. This disease was identified by the brown, cubical decay and the flat, brown sporophores that the causal fungus produces around the roots and, occasionally, on the lower boles of infected trees. Red-brown root and butt rot is normally a disease of old-growth trees. In the Pacific Northwest, it is usually not a tree killer, but it can weaken trees and predispose them to breakage, windthrow, or to other diseases or insects. Many of the dead trees in the Holly Sale area also had been attacked by Douglas-fir beetles (*Dendroctonus pseudotsugae*). Distribution of dead, Douglas-firs with red-brown root and butt rot is shown in Figure 4. It is likely that many of the living Douglas-fir in the survey area also are infected by *P. schweinitzii*.

In addition to root diseases, stem and crown diseases also were common in the survey area. All western white pines encountered had been infected by white pine blister rust (caused by *Cronartium ribicola*). Most also had been infested by mountain pine beetles (*Dendroctonus ponderosae*). Western hemlock was infected heavily by hemlock dwarf mistletoe (*Arceuthobium tsugense*). Distribution of the disease is shown in Figure 5. Western hemlock and Douglas-fir throughout the stand exhibited evidence of infection by heart rot fungi. Conks of the Indian paint fungus (*Echinodontium tinctorium*) were common on the former species and those of the red ring fungus (*Phellinus (Fomes) pini)* were common on both species. We would estimate that 50 percent of the western hemlock and 30 percent of the Douglas-firs are infected by these fungi.

DISCUSSION

Basically, our disease survey of the proposed Holly Sale area revealed three items: (1) the stand is suffering from many of the pest problems normally encountered in old-growth western hemlock-Douglas-fir stands (annosus root rot, red-brown root and butt rot, hemlock dwarf mistletoe, heart rots, bark beetles). The best control of these pests will be attained by properly harvesting the current stand and managing future stands on a shorter rotation; (2) western white pine was formerly a component of this stand but now has been virtually eliminated by white pine blister rust and mountain pine beetle. If white pine is to be grown in the area in the future, blister rust-resistant stock will have to be used; rotation ages should not exceed 125 years to avoid damage from mountain pine beetles; (3) the western hemlocks in this stand have a unique root disease problem. The Holly Sale area is the first place in the United States where black stain root disease has been found affecting western hemlock and the first place in the world where old-growth trees of this species have been found to be affected. The disease is quite severe on the site and often is associated with shoestring root rot.

Experimental evidence suggests that there are two strains of *C. wageneri*: one that normally infects young Douglas-firs and another that infects ponderosa pines, lodgepole pines, and, rarely, mountain hemlocks. The two strains appear to be fairly specific; rarely crossing from one host group to the other. The strain of the fungus found in the Holly Timber Sale area appears to be the same as the pine-mountain hemlock isolate[1/]. Therefore, we believe that Douglas-fir will not be infected by this strain of the fungus. Field evidence bears out this belief.

Ceratocystis wageneri spreads in two ways: (a) long distance spread is by insect vectors; vectors are Scolytid and Curculionid beetles that feed on roots of injured and low-vigor trees. Apparent rarity of black stain infection centers in western hemlock suggests that vectors are not very efficient on this host; (b) within established infection centers, the fungus spreads from tree to tree via root grafts and contacts irrespective of host vigor. It spreads rather rapidly along root systems--12 feet or more per year. The fungus is non-persistent (i.e., it dies with its host). Therefore, if an infection center is to remain active, it is necessary that there be a continuous network of living host roots for the fungus to infect as previously infected trees die. Because

1/ Determination made by T. Harrington, University of California

of this, the disease can be controlled by harvesting or killing all trees in infection centers plus a 50-75 foot buffer around each. If western hemlock in the Holly Sale is clearcut and the site is burned or treated to eliminate advanced hemlock regeneration, black stain on the site should be eradicated since all trees in and around existing infection centers would be eliminated. If this were done, it should be possible to regenerate the site even with western hemlock after one year if desired.

RECOMMENDATIONS

The specific management regime we would recommend for the Holly Sale Unit would be:

(1) Clearcut the stand as soon as possible--the sooner this can be done, the better to prevent spread of *C. wageneri* from this to other nearby western hemlock stands and to minimize continuing volume loss due to mortality and decay in the existing stand.

(2) Broadcast burn the site to eliminate all western hemlock advanced regeneration.

(3) Regenerate immediately with Douglas-fir and/or western white pine; or regenerate with western hemlock after all hemlock from the former stand are known to be dead. If white pine is used, obtain blister rust-resistant planting stock. White pine should be planted as a mix with at least one other species. Whatever tree species is chosen to regenerate the site, use local seed source stock and concentrate on quality planting to reduce shoestring root rot damage in the new stand.

(4) To minimize future disease and insect losses, manage stands on the site at rotations of 125 years or less.

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Figure 1.--Area surveyed in Holly Sale root disease evaluation.

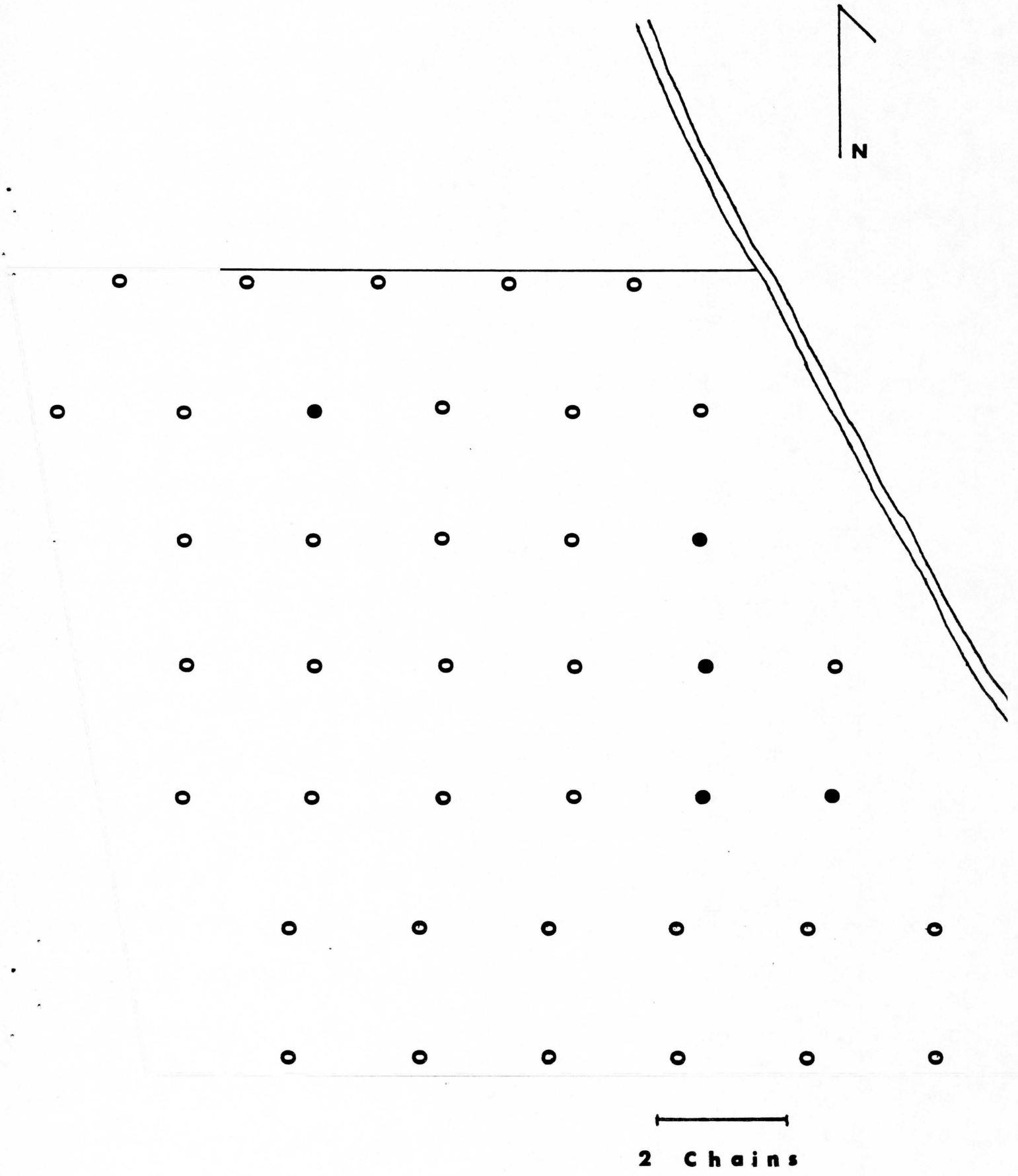

Figure 2.--Distribution of black stain root disease in survey area.

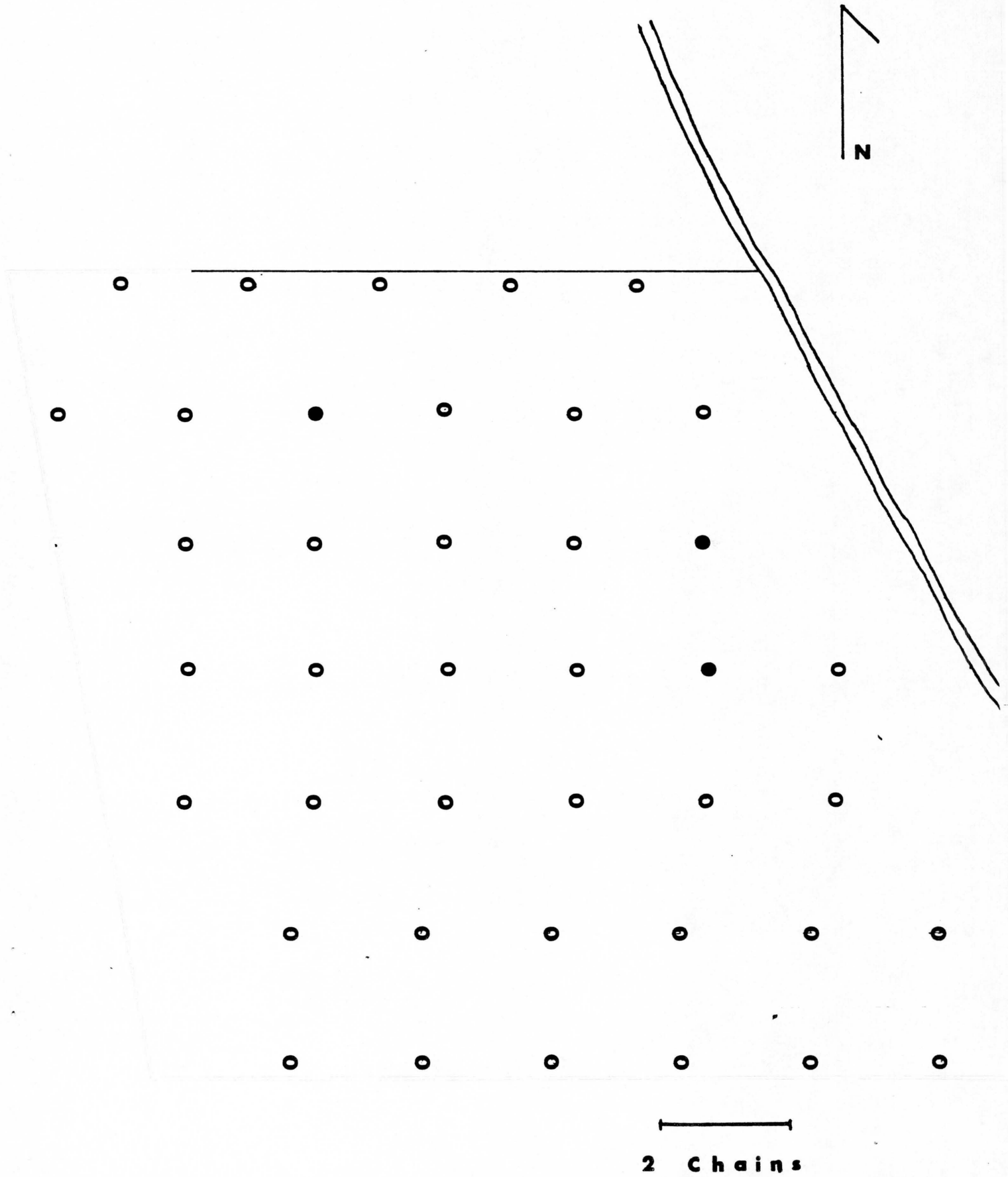

Figure 3.--Distribution of shoestring root rot in survey area.

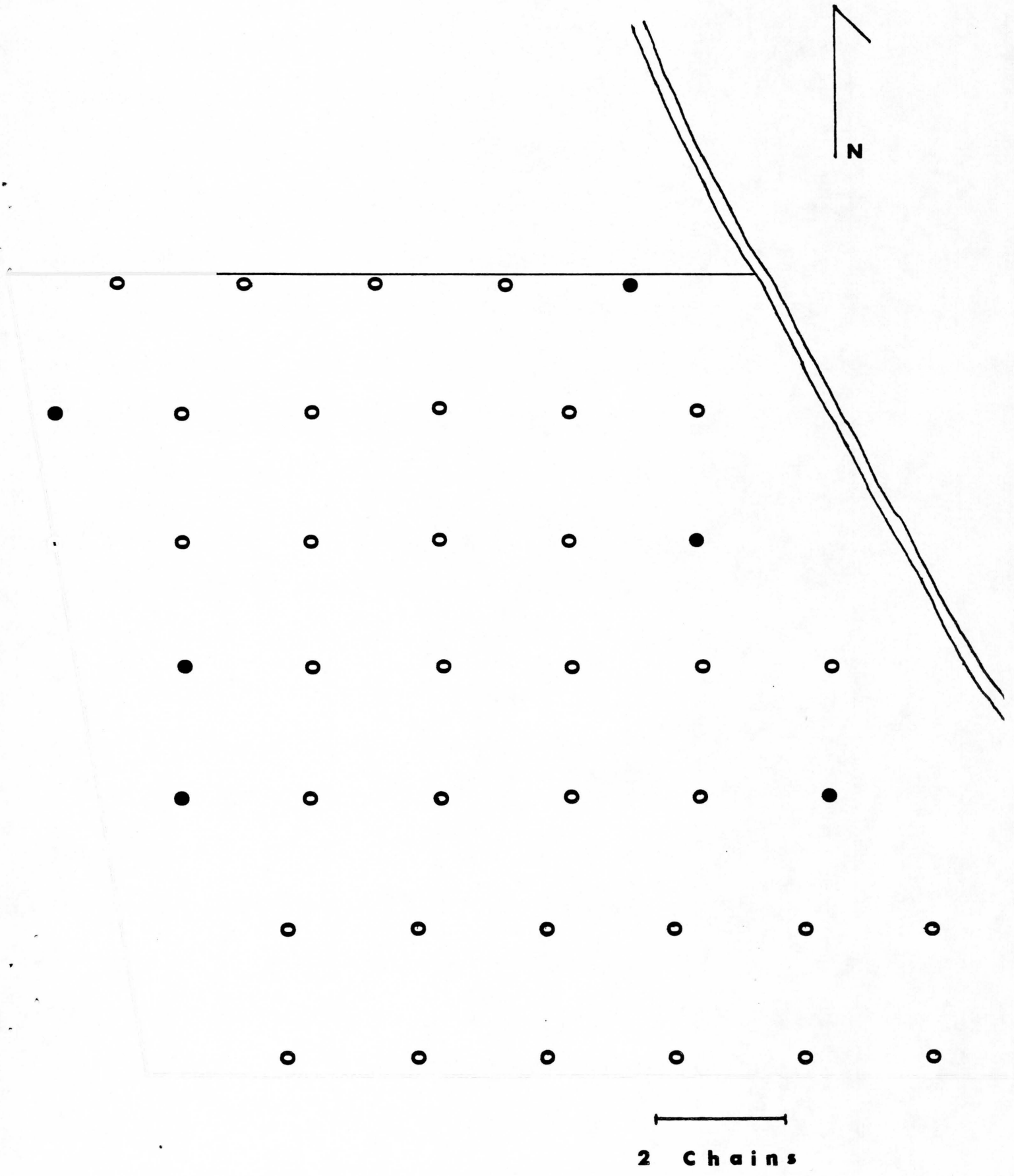

Figure 4.--Distribution of dead Douglas-firs with red-brown root and butt rot in survey area.

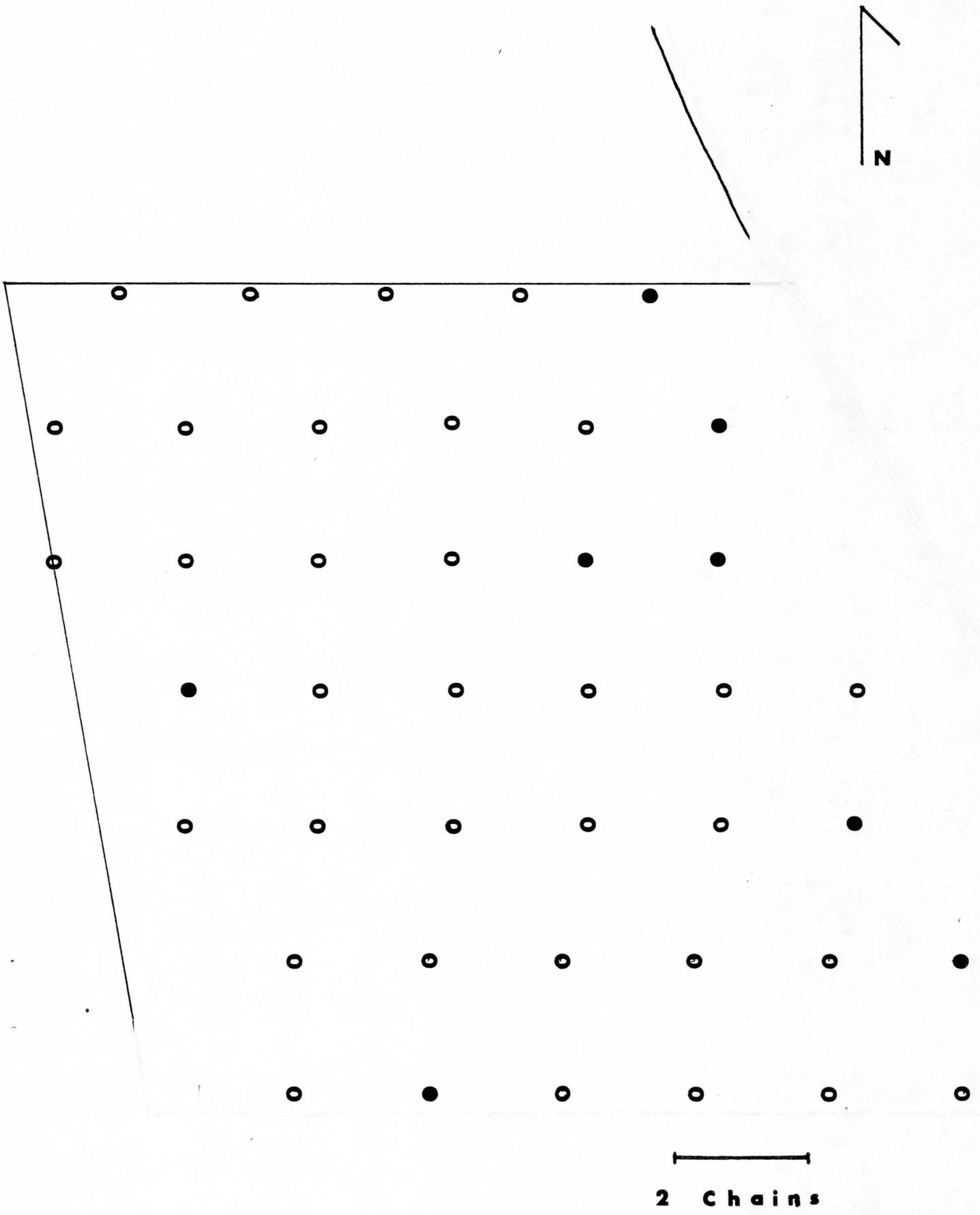

Figure 5.--Distribution of hemlock dwarf mistletoe in survey area.

Table 1.--Mean basal area per acre (ft^2) for Holly Sale survey area.

DBH Class	Western Hemlock			Douglas-fir		Western white pine		All Species		
	Healthy	Live Root Diseased	Dead Diseased	Healthy	Dead Diseased	Healthy	Dead Diseased	Healthy	Live Root Diseased	Dead Diseased
8	7.3	0	0	0	0	0	0	7.3	0	0
10	14.6	0	0	0	3.6	0	0	14.6	0	3.6
12	0	0	7.3	3.6	0	0	0	3.6	0	7.3
14	7.3	7.3	10.9	3.6	7.3	0	0	10.9	7.3	18.2
16	18.2	0	0	3.6	7.3	0	0	21.8	0	7.3
18	11.0	0	7.3	0	7.3	0	0	11.0	0	14.6
20	7.3	7.3	3.6	3.6	7.3	0	0	10.9	7.3	10.9
22	14.6	0	3.6	14.6	7.3	0	3.6	29.2	0	14.5
24	14.6	0	0	3.6	0	0	0	18.2	0	0
26	10.9	0	3.6	3.6	0	0	0	14.5	0	3.6
28	10.9	0	0	3.6	3.6	0	0	14.5	0	3.6
30	0	0	0	10.9	0	0	0	10.9	0	0
32	0	0	0	3.6	0	0	0	3.6	0	0
34	0	0	0	7.3	0	0	0	7.3	0	0
36	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0
40	0	0	0	3.6	0	0	0	3.6	0	0
Total	116.7	14.6	36.3	65.2	43.7	0	3.6	181.9	14.6	83.6

Table 2.--Mean number of trees per acre for Holly Sale survey area.

DBH Class	Western Hemlock			Douglas-fir		Western white pine		All Species		
	Healthy	Live Root Diseased	Dead Diseased	Healthy	Dead Diseased	Healthy	Dead Diseased	Healthy	Live Root Diseased	Dead Diseased
8	20.8	0	0	0	0	0	0	20.8	0	0
10	26.7	0	0	0	6.7	0	0	26.7	0	6.7
12	0	0	9.3	4.6	0	0	0	4.6	0	9.3
14	6.8	6.8	10.2	3.4	6.8	0	0	10.2	6.8	17.0
16	13.0	0	0	2.6	5.2	0	0	15.6	0	5.2
18	6.2	0	4.1	0	4.1	0	0	6.2	0	8.2
20	3.3	3.3	1.7	1.7	3.3	0	0	5.0	3.3	5.0
22	5.5	0	1.4	5.5	2.6	0	1.4	11.0	0	5.4
24	4.6	0	0	1.2	0	0	0	5.8	0	0
26	3.0	0	1.0	1.0	0	0	0	4.0	0	1.0
28	2.5	0	0	0.8	0,8	0	0	3.3	0	0.8
30	0	0	0	2.2	0	0	0	2.2	0	0
32	0	0	0	0.6	0	0	0	0.6	0	0
34	0	0	0	1.1	0	0	0	1.1	0	0
36	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0.4	0	0	0	0.4	0	0
Total	79.4	10.1	27.7	25.1	29.5	0	1.4	104.5	10.1	58.6

Note: there was a mean of 317 trees 6 inches DBH or less per acre--all western hemlock.

Table 3--Mean volume per acre (M ft^3) for Holly Sale survey area

DBH Class	Western Hemlock			Douglas-fir		Western white pine		All Species		
	Healthy	Live Root Diseased	Dead Diseased	Healthy	Dead Diseased	Healthy	Dead Diseased	Healthy	Live Root Diseased	Dead Diseased
8	2.93	0	0	0	0	0	0	2.93	0	0
10	6.45	0	0	0	1.75	0	0	6.45	0	1.75
12	0	0	3.42	1.78	0	0	0	1.78	0	3.42
14	3.53	3.53	5.29	1.83	3.66	0	0	5.36	3.53	8.95
16	9.05	0	0	1.94	3.88	0	0	10.99	0	3.88
18	5.57	0	3.68	0	3.89	0	0	5.57	0	7.57
20	3.72	3.72	1.91	2.00	3.88	0	0	5.72	3.72	5.79
22	7.60	0	1.93	7.86	3.72	0	2.00	15.46	0	7.65
24	7.63	0	0	2.05	0	0	0	9.68	0	0
26	5.89	0	1.96	2.06	0	0	0	7.95	0	1.96
28	5.73	0	0	1.91	1.91	0	0	7.64	0	1.91
30	0	0	0	6.05	0	0	0	6.05	0	0
32	0	0	0	1.88	0	0	0	1.88	0	0
34	0	0	0	3.40	0	0	0	3.40	0	0
36	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0
40	0	0	0	2.00	0	0	0	2.00	0	0
Total	58.10	7.25	18.19	54.28	22.69	0	2.00	112.38	7.25	42.88